

Acoustic Applications for Thermography

DOE/NIH Workshop on Thermographic Approaches to Medical Diagnosis and Therapy

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U.S. Department of Energy
Pacific Northwest National Laboratory

Microscopy Technologies

	<u>Acoustic</u>	<u>Magnetic Resonance</u>	<u>Optical Con-focal</u>
Penetration	Excellent	Excellent	Poor
Acquisition	Fast	Slow	Fast
Contrast	Excellent	Excellent	Good
Sensitivity	Good	Poor	Good
Information	Elasticity, density, & viscosity	Chemical & physical	Selective dye absorption
Spatial Resolution	Scalable (~1-80 um)	Scalable (~10 um)	Excellent (1 um)

Acoustic microscopy can be exploited for biological applications.

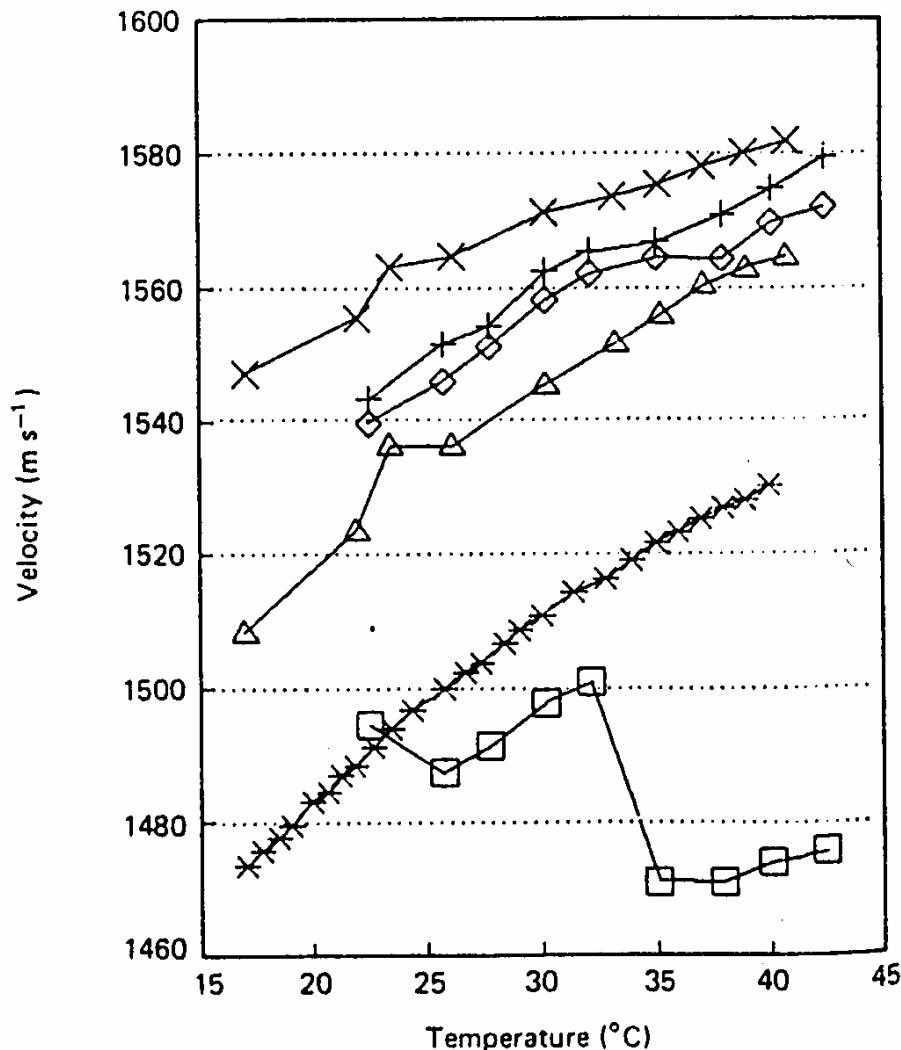
Perspectives

- Promising Acoustic Biomedical Applications
 - Thermography, Hyperthermia, Lithotripsy, Sub-cellular Imaging, etc.
- Advancements in enabling technologies
 - Electronics
 - Transducers & Phased Arrays
 - Computational

Acoustic microscopy is usable in real time to attack biological problems in cells and tissues.

Heat Changes the Acoustic Properties of Cells

In Vitro



Liver

Breast muscle

Breast parenchyma

Kidney

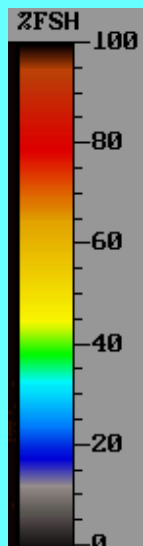
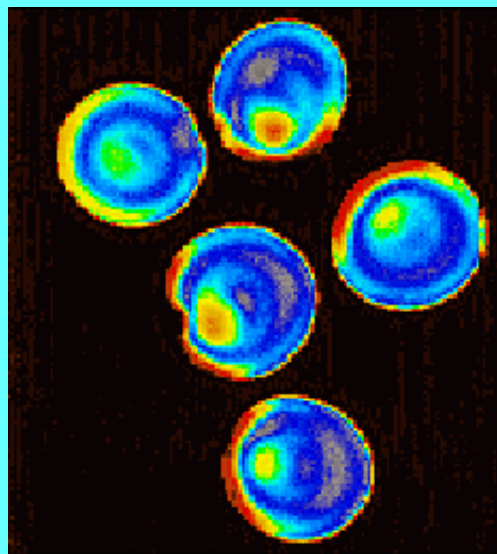
Water

Breast fat with parenchyma

Acquired from M.T. Nguyen and U. Faust, *Ultrasonic International*, 1992 Vol. 30, No. 2, p. 128.

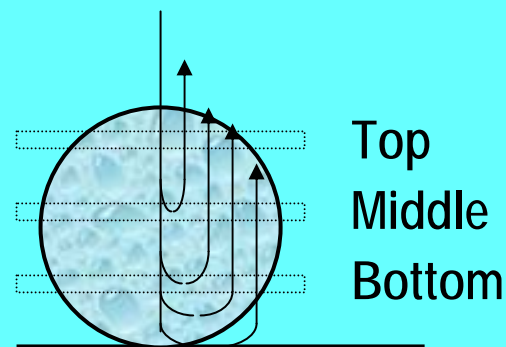
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Acoustic Microscopy of *Xenopus* Oocytes



Reflection from
Glass Plate

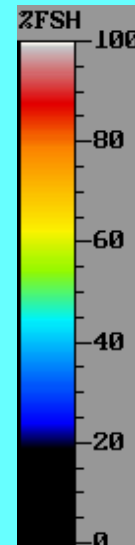
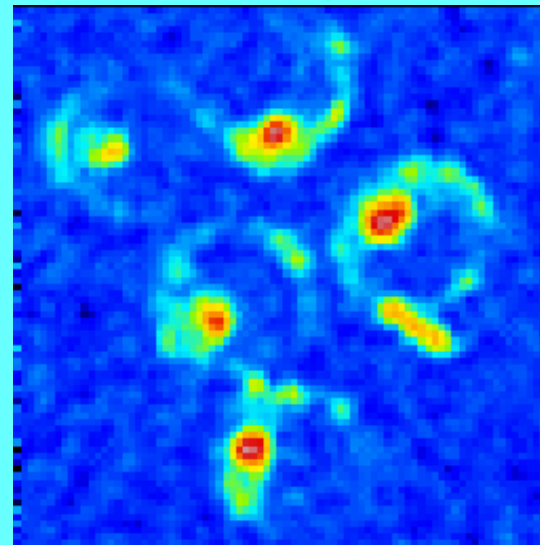
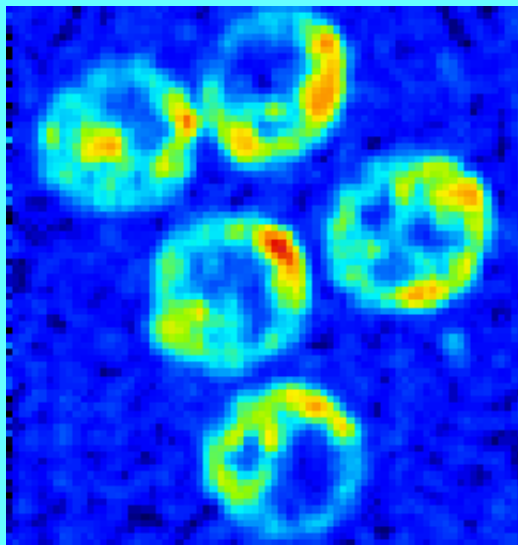
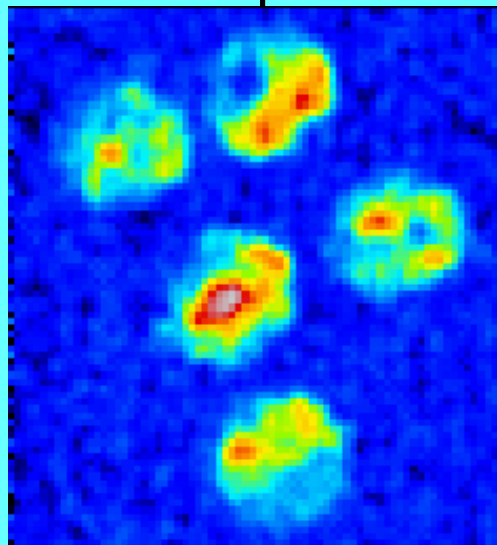
1 mm



Top

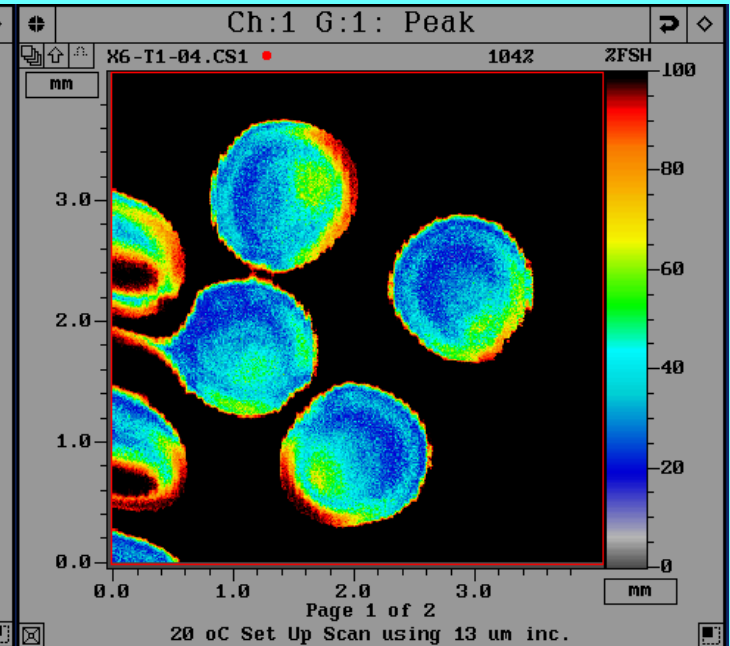
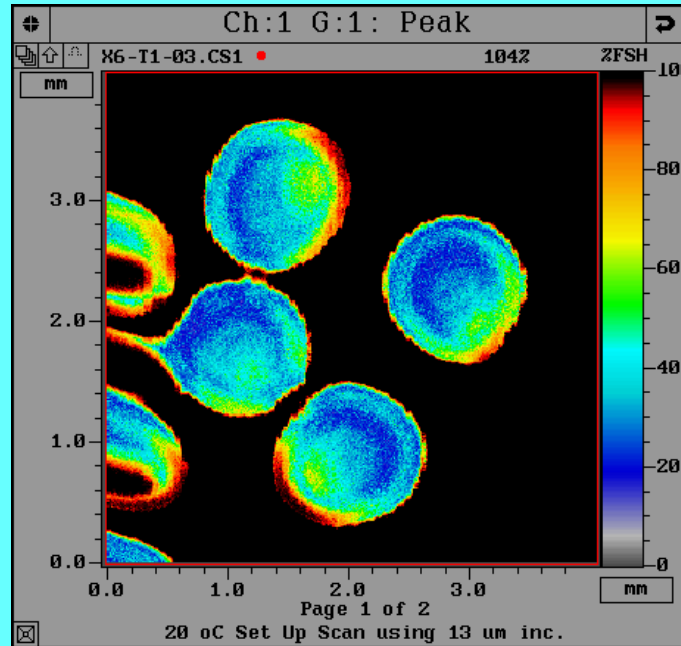
Middle

Bottom

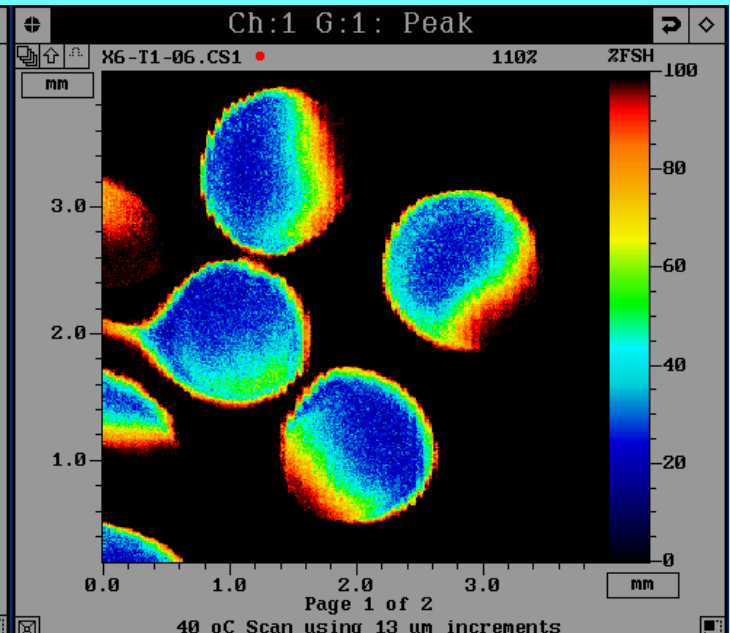
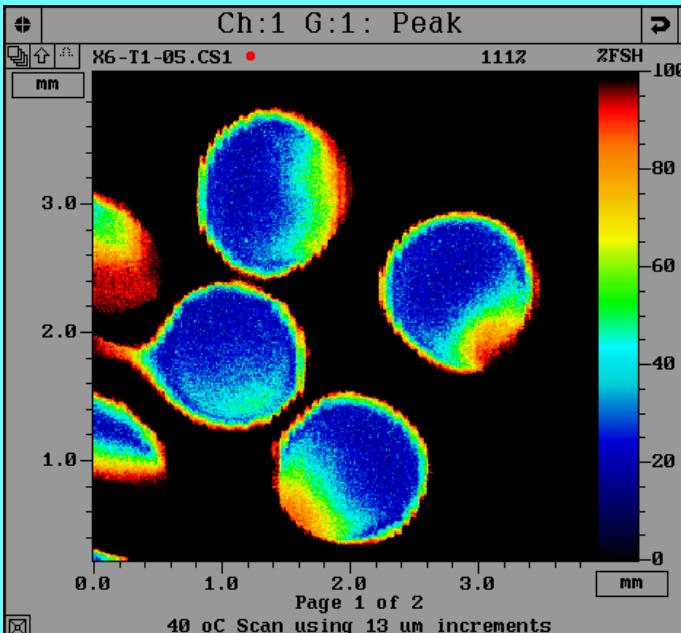


Xenopus Oocytes: Before and After Heat Stress

Before:
Cells at
20° C



After:
Cells at
40° C



Acoustics can simultaneously damage and image

Model 3-D tissue systems

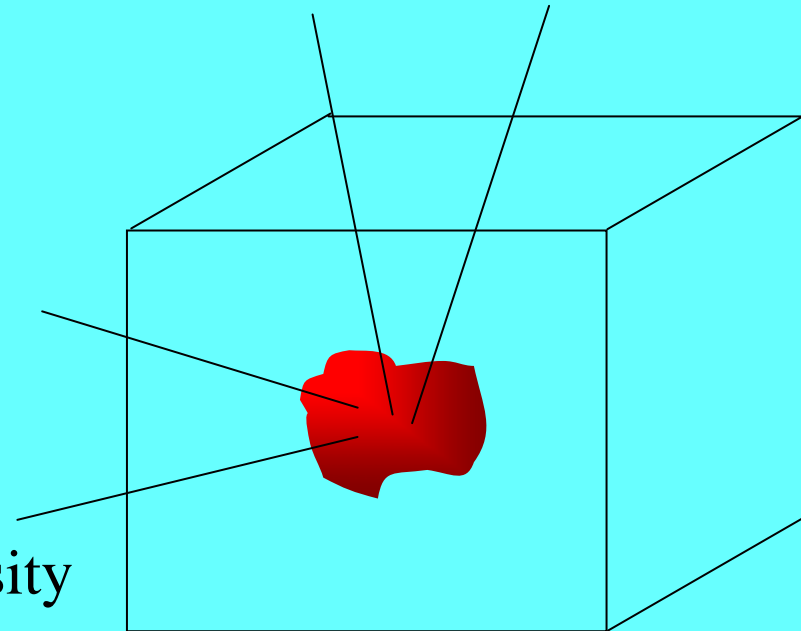
- tissue damage
- tumor damage
- inhomogeneous media

Damage:

High Intensity
Low Frequency

Image:

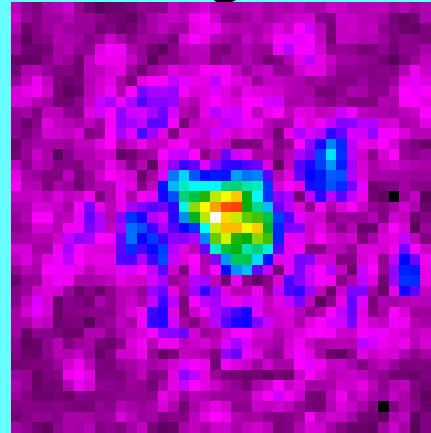
Low Intensity
High Frequency



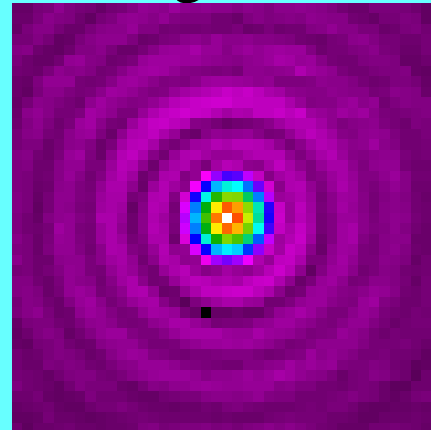
Problems: Distortion of acoustic fields in inhomogeneous media

- Limits resolution
 - Increases damage region
 - Distorts and steers beams
-
- **Solutions:**
 - Phased arrays (adaptive/dynamic focusing)
 - Modeling to account for effects

Inhomogeneous (Ti-17)



Homogeneous

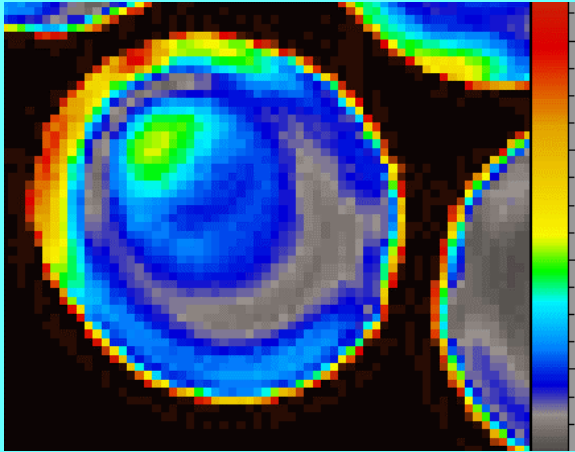


Focused
Transducer
(9 MHz)

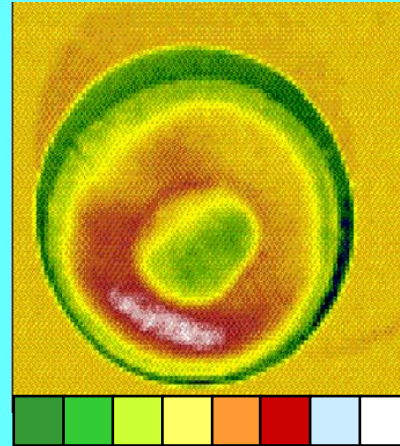
3.1 cm x 3.1 cm

Multi-Technology Microscopes for Thermography

Acoustic

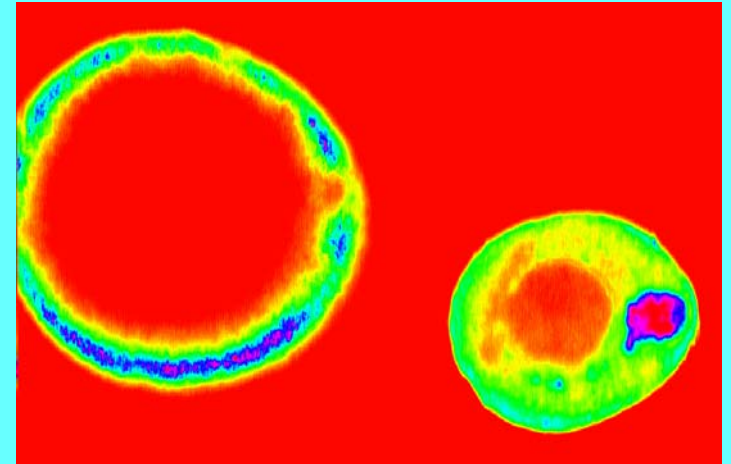


Magnetic Resonance



← Water Lipids →

Optical Confocal



Current

Developing

Multiple modes of imaging and data collection in cells and tissues can provide insights unavailable by other single approaches.

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